METROPOLITAN TRANSPORTATION COMMISSION

SAFE

EVALUATION OF CALL BOX ACCESS OPTIONS FOR HEARING/SPEECH IMPAIRED USERS

TECHNICAL MEMORANDUM 3E:

Final Report – Executive Summary

For

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1.   INTRODUCTION

The authority for operation of a call box system is found in California Streets and Highway Code Sections 2550 *et seq*. Under this legislation, each county may, with a majority vote from the cities and the county, form a Service Authority for Freeways and Expressways (SAFE) to purchase, install and operate call boxes within its boundaries. There are approximately 17,000 call boxes operating in California. It is estimated that approximately 2,000 to 3,000 additional call boxes will be installed in the future, and these will be primarily on freeway extensions, major metropolitan arterials, and in rural areas.

SAFE Administration

Each SAFE is an independent local agency established under the authority of the State Government Code, as referenced above. Each SAFE is funded through the collection of a $1.00 annual vehicle registration fee that is distributed back to the local agencies by the State of California. SAFEs are typically governed by a locally appointed board of directors and managed by one or more professional managers. With the exception of San Diego, the SAFE Boards consist of the same board members and staff that manage either the regional transportation planning agency or the local Council of Governments.

California Department of Transportation (Caltrans) and the California Highway Patrol (CHP) in cooperation with SAFEs provide planning oversight for call box systems jointly. The SAFE agencies submit implementation plans to the two oversight agencies. Caltrans and/or the CHP working with SAFEs jointly establish call box equipment, location and installation specifications, as well as operational criteria prior to implementation.

Call Box System Operations

California call boxes consist of a weather resistant aluminum or plastic case attached to a 14' breakaway pole, a solar collector to charge batteries, and an antenna on the top. The case contains a transceiver, a controller card and batteries. When a caller activates a call box, either by lifting the handset or pressing a button, the internal microprocessor generates a cellular radiotelephone call to a live operator answer center. The call is carried by a commercial cellular telephone carrier that was selected through competitive bid by each individual SAFE.

Virtually all operations services (call answering, call box maintenance and cellular telephone service) are provided through contracts managed by the SAFE staff. Until recently, state law required call answering services to be provided by contract with the CHP. This legislation requires the SAFEs to reimburse the CHP for all costs related to the services that they provide. Recent legislation now allows SAFEs, with approval from the CHP, to outsource or subcontract call answering services. The San Diego SAFE is the first SAFE to privatize call answering services under this legislation, and the MTC SAFE is in the process of implementing a private call center, which is currently answering a portion of the calls.

2.   PURPOSE OF STUDY

The purpose of this study is to evaluate the different options available for access to hearing and speech-impaired call box users.

The Metropolitan Transportation Commission/Service Authority for Freeways and Expressways (MTC SAFE) entered into a contract with TEL/ADVISORS to perform an " Evaluation of Options to Enhance Call Box Access for Hearing/Speech Impaired Users." This report, Technical Memorandum 3E – Final Report, is an executive summary of the findings and results of the evaluation.

MTC SAFE retained the consultant on behalf of CalSAFE, a voluntary association of California SAFEs, which was established to assist the SAFEs in dealing with issues of mutual concern, support statewide consistency in the implementation of SAFE state statutes, and to share information. One such area of

concern of the SAFEs is the provision of call box access for disabled motorists, in the face of changing technology, uncertain legal mandates and limited financial resources.

When the ADA of 1990 was passed several large California counties had already implemented call box systems.
The Department of Justice issued ADA implementation regulations for public agencies (28 CFR Part 35) on July 26, 1991, which took effect on January 26, 1992. Section 35.150 of these regulations established a standard of accessibility for existing public facilities that applies to existing call box systems. The Access Board published an Interim Final Rule (36 CFR Part 1191) that applies to states and local governments, including a section on "Roadside Emergency Communications Systems." However, a final rule has yet to be released, leading the SAFEs to proceed independently, and through CalSAFE to investigate various access alternatives.

3. SUMMARY OF TASK REPORTS

The following primary tasks were performed relative to evaluating the available alternatives for improving access for the hearing/speech impaired:

- •   Review and identify legal requirements and other issues, which impact call box accessibility.
- •   Identify available access alternatives.
- •   Develop criteria for use in evaluating access alternatives.
- •   Conduct evaluations and apply criteria to the equipment, usability and system compatibility aspects of each access alternative.

The results of these tasks have been detailed in several technical memoranda issued during this project. Each of these reports builds upon information discussed in the previous report and therefore, the reports should be read in sequence. The Technical Memoranda issued for this project are listed below:

1A: Legal Review – summarized federal and state accessibility requirements.

1B: Available Access Alternatives – identified available alternatives for improving access.

1C: Access Options Issues and Factors – discussed the issues and factors impacting the access alternatives.

2A: Evaluation Criteria - outlined the criteria to be used in evaluating access options.

2B: Evaluation Process - described the methods and processes to be used to evaluate the access options relative to the requirements of each criterion.

2C: Access Options - summarized the options to be evaluated.

2D: Evaluation Process Scope of Work – detailed the evaluation steps to be followed.

3A: Technological Quality – described the technological quality of the access options.

3B: Usability Evaluation Summary – presented the results of an evaluation of the access options conducted by volunteer users.

3C: System Compatibility – analyzed the compatibility of the access options with other elements of the call box system.

3D: Evaluation Matrix and Projected Utilization – summarized the results of all the evaluations in a matrix format and presented demographic information on the representation of hard-of-hearing, deaf and speech impaired individuals within the general population.

4. AVAILABLE ACCESS ALTERNATIVES

The access options to be evaluated for this project were selected by the Technical Advisory Committee (TAC). The TAC is composed of representatives from several SAFEs and provides advisory oversight for the project. The access options selected by the TAC for evaluation are briefly described below:

- **Comarco TTY**. This option provides a TTY keyboard on a retractable shelf mounted below the call box enclosure and a display screen mounted within the enclosure to send and receive messages. This device also allows for a push button response to "yes/no" questions. Simultaneous voice communication with the operator is also possible. The LA SAFE implemented this access option in 1999.

- **Comarco Yes/No device**. This is a newly developed device that allows for a push button response to "yes/no" questions but does not include a TTY keyboard. The MTC SAFE is currently implementing this option on a test basis.

- **Denbridge TTY**. A text telephone (TTY) keyboard and display screen mounted within the call box enclosure is provided to send and receive messages. Simultaneous voice communication with the operator is not possible. This access option was developed for the Ventura SAFE in the mid-1990s and is currently in use only in Ventura County.

- **Call Connect Light**. The call box displays a light indicating when the call has been received at the CHP or private call-answering center; voice communication with the operator is also possible. A user who cannot hear the operator, but can speak, will be able to speak information through the handset to the operator. Currently, call boxes with call connect lights are deployed by all SAFEs either partially or completely throughout their systems.

5. EVALUATION CRITERIA

The following evaluation criteria were established for use in evaluating the access options:

- Legal Compliance

    - FCC Certification for Call Box
    - Complies with Federal Title II Requirements
    - Complies with Title 24 of California state law
    - Acceptable to the CHP
    - Acceptable to Caltrans

- Technological Quality

    - Complies with call box specifications
    - Equipment reliability and acceptable failure rate
    - Frequency of repair and replacement data for those devices that are currently in use

- Failure and success rates for:

  - Initial activation of the call box
  - Connection to the cellular network
  - Connection to the call center
  - Enabling successful communication with the call center operator

- Mean time between failure (this is a statistic that indicates the elapsed time before a piece of equipment first must be repaired.)

- Compatibility With Existing Call Box System Components

  - Review of equipment specifications
  - Review of operational and repair data
  - Review of vendor documentation
  - Conducting test calls
  - Analysis of call answering procedural and training requirements
  - Observations at call box call answering centers
  - Observations during user testing

- Acceptability By Users

  - Call Box operating instructions that are simple and easy to read and understand
  - Effective communication with the operator
  - Call boxes that have a display screen should be easy to read
  - Call boxes that have a call box buttons should be easy to use
  - Call boxes that have a keyboard should be easy to use
  - Ease in determining whether or not a call was received by the answer center
  - Time required for caller to initiate call
  - Time required to communicate with operator

- Acceptable Level of Projected Utilization

- Cost Relative to Installation, Operation And Maintenance

6. MAJOR FINDINGS

The following subsections summarize the major findings:

A. Legal Review

California SAFE agencies are required by both federal and state law to make program services available to hearing and speech impaired drivers and passengers. However, few specific requirements are detailed in the federal and state regulations governing accessibility to call box systems. The key legal points identified by the consultant are listed below:

- No requirements or standards have been adopted by either state or federal authorities that specifically define how call box services are to be made accessible. The Justice Department published "Interim Final Guidelines" (call box access for persons with physical disabilities) on June 20, 1994. Although those guidelines were never adopted, and therefore do not have the effect of law, they were developed as a result of extensive public testimony and are the only guidelines that are specific to call boxes.

- Title II of the Americans with Disabilities Act (ADA) specifies a series of required steps which must be followed by each SAFE in establishing access program standards, allowing for substantial discretion relative to the means of access and funding levels for the provision of access.

- The majority of the court rulings related to call box services have been favorable toward agencies that appear to have made a reasonable attempt to follow the required process. *(See Schonfeld v. City of Carlsbad and Miller v. City of Johnson City, Tennessee).*

- Title II of the ADA was enacted in 1990 to extend the prohibition against discrimination to all services, programs and activities provided by state and local governments or any of their instrumentalities regardless of the receipt of federal financial assistance. The consultant's research indicates that California SAFE call box programs are subject to these statutes. It is yet to be determined how much, if any, of this responsibility the SAFEs share with state agencies such as the CHP and Caltrans.

- An agency is not required to take any action that is an undue financial or administrative burden or fundamentally alters the nature of the program or activity. The above referenced Code, the consultant believes that, based upon funding availability, an agency may elect to install 50 TTYs each year, instead of 200 at one time, or that funding limitations will allow the installation of a "call connected light" only, instead of TTYs. Such decisions are subject to court challenge and therefore should be fully reviewed by each SAFE's legal counsel and be well documented. The "undue burden" provision of the ADA may represent an important consideration for SAFEs with limited financial resources.

- New versus Existing Systems: All facilities designed, constructed or altered by, on behalf of or for the use of a public entity must be readily accessible and usable by individuals with disabilities, if the construction or alteration is begun after January 26, 1992 (Technical Assistance Manual [TAM], II-6.1000. Facilities constructed or installed prior to January 26, 1992 are considered "existing systems" and must be readily accessible "when viewed in their entirety" (28 CFR 35.150(a)). The standard for providing accessibility to an "existing system" is more flexible than the standard for a new system.

  The accessibility planning process as applied to existing programs allows the Board of each SAFE to take undue financial or administrative burden into consideration when selecting the type of device and in scheduling the installation. The process also requires input from members of the disabled community.

  Note:

  - The operator of an existing program is only required to make the program accessible when viewed in its entirety.

  - The service provider for an existing system is required to perform a "self assessment" and adopt a reasonable transition plan for making the system accessible as quickly as possible.

  - If funding limitations allow an existing system operator to retrofit only a percentage of the system call boxes, there appears to be no requirement to remove the remaining inaccessible call boxes.

  - Absolute "equal access" is not required by ADA legislation. Based upon the consultant's research, the following statement provides a representative example of the Department of Justice interpretation of the law:

    "In the case of providing access to the hearing and speech impaired, equal access is probably not technologically possible and absolute equal access is not required by law.   Equal access is a goal. Access programs implemented by agencies that follow the legally required process, involve the disabled community and follow through by providing reasonable access appear to have been generally upheld by the courts."

The Thalheimer Case

The complaint in the Thalheimer case takes the position that all of the call boxes located on Los Angeles County freeways are inaccessible to the deaf, hearing-impaired and speech-impaired travelers. The complaint alleges that the call boxes are inaccessible because they require voice communication and are not equipped with telecommunication devices for the deaf or other devices that enable non-voice communication. The complaint further alleges that the defendants have violated both state and federal anti-discrimination laws by effectively denying deaf, hearing-impaired, and/or speech-impaired equal access.

Los Angeles SAFE and Caltrans entered into a Memorandum of Agreement to settle out of court the Thalheimer case on March 23, 1999. The terms of that agreement are on the Internet at www.mta.net/safe/safe_moa_mta.HTM. A couple of the key terms of the agreement are summarized below:

Para 2.3   LA SAFE shall make each call box accessible to motorists who are deaf or who have hearing and/or speech impairment.

Para 2.9   The entity receiving and responding to a TTY call shall be the same entity that responds to voice calls.

- Calls shall be responded to in same priority as voice calls.
- The entity shall install equipment capable of receiving and responding to TTY calls at every dedicated call box call-taking position.
- Unless the entity answering the calls is the CHP, the LA SAFE shall be the guarantor of the entity's performance of its obligations under the contract.

B. Technological Quality Evaluation

This section presents a summary of the results of the technological quality evaluation. Also included are the consultant's findings relative to functionality issues associated with the technology of the access devices.

To evaluate the technological quality of the access devices, the consultant attempted to obtain equipment specifications for the access devices so that they could be compared with the specifications of the standard call box.

The consultant also tested the voice and data transmission features of the access devices during user testing. This enabled the consultant to evaluate the functionality of the keyboard, display screen and voice/data transmission protocol for the devices.

In addition to compliance with baseline technical specifications, access options were also assessed against performance reliability criteria to evaluate the potential for failure or breakdown.

- **General Specification Compliance.** The manufacturers of the access options indicate that each option generally complies with the specifications for many of the call box internal components listed. The consultant noted several areas in which the features of the access options caused a deviation from the specifications of the standard call box system. While these deviations do not appear to significantly impact the ability of the access devices to provide communication alternatives to the hearing and speech impaired, in some cases they impact the usability of the devices.

- **Keyboard**. The Denbridge TTY and Comarco TTY devices each include a TTY keyboard, which is an addition to the standard call box assembly specifications. The Denbridge TTY keyboard does not conform to standard TTY specifications and therefore, some key locations will be unfamiliar to users of standard TTYs. The Comarco TTY uses the standard TTY layout.

- **Display Screen.**   Several functional issues have been identified related to the display screen used in both the Comarco and Denbridge access options. These issues are discussed below.

- **Sun Glare**: Sun glare reflecting off of the display screen has been noted as a problem in both the Denbridge and Comarco access options. The sun glare significantly reduces the ability to read the screen clearly. However, this problem is more severe with the Comarco option. The consultant observed this problem during user testing, when the majority of the tests were conducted with the sun directly on the screen. Depending upon the location of the call box and the time of day, sun glare may or may not be a significant problem. During user testing it was noted that the use of sunglasses made the screen even more difficult to read.

- **Language:** During user testing the consultant noted that the language displayed on the screens and instructions of both the Comarco and Denbridge boxes contain words, abbreviations, and symbols that were not understood by many test participants. For example, some of the test participants did not understand the abbreviation "CHP", but did understand the word "police."

- **Voice vs. TTY Button:** Persons needing to use the voice function of the call box frequently pushed the TTY button. Several participants, both hearing and non-hearing, did not know what a TTY was. In addition, because TTY was selected the operator attempted to interact with the caller using the TTY rather than voice.

- **Call Box Screen Protocol:** During user testing the consultant noted that the message displayed on the screen of the Yes/No call box while a call was initiated to the answer center read: "Help being sent". At this point in the transaction, assistance has <u>not</u> yet been sent. The caller is waiting for a dispatcher to answer the call box, however, the message "Help is being sent" is likely to lead the caller to believe the transaction is complete and to hang-up. If this happens and the call is lost before it is actually answered, assistance will not be sent and the caller will not know to reinitiate the call. This occurrence could be a problem in an area where calls are put on hold for long periods of time.

- **Transferred TTY Calls:** In the case of both the Comarco Yes/No box and the Comarco TTY box, calls must be transferred to a TTY at the call-answering center to be answered. During that transfer, both of these boxes display what appears to be a blank screen because a cursor blinks in the upper left-hand corner of the screen. During user testing it was observed that most test volunteers did not notice the blinking cursor during this call transfer. If a call takes longer than a few seconds to transfer, the caller may believe the call has been lost and may attempt to reinitiate the call.

- **Word Breaks:** The Comarco TTY and Yes/No call box screens display four rows of text with 10 characters per line. After a row contains ten characters, the next line begins, even if a word is broken at an inappropriate place on the screen. The software clearly does not function in the same manner as word processing software, which ends a line with a finished word. The Comarco screen display also deviates from the standard TTY display, which is designed to be read in one continuous line. The confusion to callers caused by this word break protocol is likely to be exacerbated by typographical errors, misspellings, and user nervousness. The following is an example of this problem:

> You can re
> ceive a me
> ssage like
> this one.

- **Speed of Message:** During user testing, a few users commented that the message scrolled by too quickly for them to read on the Denbridge TTY. Others were re-reading instructions in the door and missed key comments while they were displayed on the screen. Although the speed of the scrolling message can be controlled by the call answering center operators, it is unlikely that callers will be aware that they can request that the operator slow down the speed of transmission. Speed is only a problem relative to pre-programmed messages, as the default speeds for pre-programmed messages on the Denbridge call answering system tend to be too fast for most users.   Once the operator establishes a typed dialog with the user, speed is no longer a problem because the messages appear as the operator types, (i.e., at a speed that is slower and therefore easier to read)**.**

- **Integration of Voice and Data Communication.**   The Comarco and Yes/No devices each allow for both voice and data communication during the same call event so that a caller who can speak may do so in response to messages displayed on the screen, instead of using the keyboard. Likewise, a caller who can hear may reply to voice communication by using the keyboard. This capability is not provided with the Denbridge TTY. The Ventura SAFE has not noted this issue as a problem nor did participants utilize this feature during user testing.

- **Transmission Protocol.** The Comarco devices use the Baudot transmission protocol and the Denbridge TTY uses ASCII. With the ASCII format, the consultant noted fewer garbled messages during user testing. Garbled messages often transposed letters, repeated letters, or inserted undistinguishable symbols into the message. The garbled message seems to be an issue with sending Baudot signals over the cellular network and cannot be fixed. The Comarco TTY can be configured with the ASCII protocol.

- **Call Answering Equipment**. The Denbridge is answered by a PC based system with a TTY modem. A TTY call can be transmitted on the same line as a voice call or on a separate line, but the operator must switch the call to the TTY if the same line is used. The Comarco TTY transmits calls on the same line as voice calls. Therefore a "coder/decoder" device at the answer center is used to display the messages from the TTY. The Yes/No device used by the MTC SAFE will transmit calls on a separate line and therefore will not use the "coder/decoder", but will require a TTY at the workstation to receive the call.

- **Cellular System**. All of the access devices are compatible with the current cellular call box and the analog cellular network. However, in systems using older cellular phones, loss of signal strength may be experienced.

- **Processor.** Denbridge and Comarco developed different processors to control call box operations. The Comarco controller can accommodate both the Comarco TTY, Yes/No device and the Denbridge TTY.

- **Electrical**. Increased battery size and upgraded solar panel may be necessary to accommodate the power demands of the addition of the Yes/No screen and Comarco TTY to existing call boxes. This will need to be determined by Comarco at the time of proposal after assessing the existing battery output.

- **Mechanical**. When access devices are added to the standard call box additional signage may be necessary to indicate that options for the hearing and speech impaired are available. The handset cord of the Denbridge box should be secured with a bracket to prevent the cord from interfering with the closure of the door covering the TTY.

- **System Control, Configuration, and Programming**. All access devices conform to the original call box specifications in these areas according to the manufacturers. Additional alarm and diagnostic features have been added to monitor and test the keyboard, display screen, and buttons used with the access devices.

- **Equipment Reliability**

    - Comarco TTY and Yes/No Options Reliability Issues:

        - **Connection to the call center**: As the call is connecting to the answering center, the caller can hear the call box "dialing out" through the handset, which gives some indication that the call is connecting. This feature does not help the hearing impaired, but may provide some level of confidence to those who can hear, and those who can hear but are speech impaired.

        - **Communication with the call center**: During call center observations, the consultant noted that several time-consuming steps were required of the operator to begin communication with the caller. The operator first must turn on the TTY at the workstation, then hit the return key three times, then select the pre-programmed answer phrase to send to the call box, and finally send the message to the call box. These steps require approximately 15 seconds.

        - **Concern:** While these steps are being taken by the operator there is no indication to the caller at the call box that the call was being answered at the call center. The consultant noted that this "pause," where nothing seemed to be happening, led to hang-ups from callers. Although once established, communication between the operator and the caller was usually successful. The word wrap problem noted earlier in this report led to caller misunderstanding relative to the message sent by the operator.

    - Denbridge TTY Reliability Issues:

        - **Handset de-activation**: The Denbridge TTY handset is de-activated once the TTY is activated, which is a design feature which provides less flexibility for the caller that is hearing impaired but may be able to speak.

        - **Answering software**: The answering software utilized by the Denbridge TTY at the call answering center appears to function as intended. However, during user testing the consultant noted that the choice of wording for some of the pre-programmed messages caused confusion for the caller. For example, the first message transmitted after the operator answers the Denbridge TTY is "How may I help you?" This type of open-ended question is not a quick and efficient method of determining the caller's needs, because it requires more time as the caller and the operator communicate back and forth by TTY. Due to the complexity of the programming a Comarco technician is needed to reprogram any stored messages.

- **·** Call Connect Light Reliability Issues:

  - **·** The consultant was not able to obtain specific information on the reliability of the call connect light from the vendors or the individual SAFE managers.

C. SYSTEM COMPATIBILITY EVALUATION

The system compatibility of the access options was evaluated relative to the cellular telephone network and call answering center hardware and software. In addition, the impact of the access devices on call center operating procedures and staff training was also evaluated.

The consultant's findings relative to the compatibility of the call box access options with the existing cellular system and the hardware, software and call-processing procedures utilized in CHP communications centers is summarized below:

- · All of the access options are compatible with the cellular network. Some signal and connection failures were encountered during the consultant's limited random testing, however these problems were the result of weak cellular signal strength and not attributed to the access devices.

- · The Denbridge TTY and the Comarco TTY and Yes/No options are not compatible with the CHP and private call centers unless additional equipment, call handling procedures and operator training are provided.

- · The call connect light requires no additional call center hardware or software, but does require call handling procedural changes and operator training.

D. USABILITY EVALUATION

The usability of access options was evaluated through a user testing process conducted with volunteer hearing and/or speech impaired subjects. In addition, non-impaired volunteers were included in the user testing to determine if and how access option features impact the use of call boxes modified with access options. The user testing process also provided an opportunity to identify hardware and software functionality issues relative to the options.

The user testing for this project was intended to provide information to the SAFEs about how users with hearing and speech impairments evaluated the devices that were designed to provide access to call box services for these groups.

During user testing, each subject was asked to use each device and then complete a questionnaire that requests specific information regarding the subject's perception of the device's usability. During the observer evaluation, each subject was observed accessing the various call box devices and evaluated according to the established criteria (e.g., time taken to complete the call, success or failure in completing the call).

Participants

The user testing plan for this project called for approximately 20 members, between the ages of 16 to 80, from four groups of motorists. These groups were individuals with:

- ▪ Limited hearing ability, i.e., individuals who are hard of hearing (HH)
- ▪ Very limited or no hearing ability, i.e., individuals who are deaf (D)

- Normal hearing and speaking ability (H)
- Speech impairments (SI)

Speech and hearing-impaired subjects were recruited through agencies frequented by individuals with speech and hearing disabilities (e.g., San Diego Deaf Community Services, Self Help for Hard of Hearing People, Inc. San Diego Chapters, San Diego State University Communication Clinic). Representatives of these groups assisted the consultant team in selecting participants. Many of the speech-impaired subjects were former clients of consultant team member and speech therapist Charlotte Hicks. In selecting participants the goal was to include a range of characteristics among those chosen so that varying perspectives on the access options could be obtained.

Sample Size

As noted above, subjects representing each of the four groups were recruited to participate in user testing. Statistical power analysis methodology was utilized to determine the size of the user-testing group [1]. Power analysis indicates that groups of 20 for each demographic are sufficient to determine how the reactions to the access options differ among the four groups tested. Twenty subjects were obtained for the hard-of-hearing, 23 for the deaf group and 20 for the hearing group. Unfortunately, even though the consultant team made numerous contacts with groups representing the speech impaired in order to obtain volunteers for user testing, the consultants were able to obtain participation from only 14 subjects, not the 20 originally desired. Although a larger sample of 20 would be desirable, it would not likely yield any different preferences or outcomes than a sample of 14. Both samples are considered "small samples" and neither would be used to estimate how a large population would respond.

A summary of the results of the user testing is as follows:

  Average score for all groups combined for each device:

- The Yes/No (YN) call box received the highest rating, 81%
- The Denbridge TTY (DTTY) received the next highest overall rating, 76%
- The Comarco TTY (CTTY) received an overall rating of 69%
- The Call Connect Light (CL) call box received an overall rating of 62%

  Additional findings concluded:

- The HH group CLEARLY favored the YN call box
- The D group CLEARLY favored the CTTY call box except for the keyboard where they favored the YN call box
- The H group favored the YN and DTTY call boxes
- The SI group was the least consistent, but favored the DTTY call box in seven of eight features even though they used the handset to connect to the operator. It appeared that they liked the idea of a TTY but did not like being forced to go through an interview before the call would connect.

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[1] (Cohen, J. 1977. *Statistical Power Analysis for the Behavior Sciences,* [Revised edition]. New York; Academic Press Inc.; Cohen, J. 1992. *A Power Primer.* Psychological Bulletin, 112[1], 155-159.)

Table 1: Summary of Ratings by Groups

Group	Call Box Preference	Overall Ratings (all features)	Comfortable Using on the Road	Recommend Installation	Call Success	Average of the Percents	Relative Strength of Preference
HH	YN	85%	85%	60%	85%	78.8%	Strong
D	CTTY	76%	78%	78%	85%	79.3%	Strong
H	YN/DTTY	95%	100%	80%/75%	55%	81.8%	Very Strong
SI	DTTY	89%	93%	64%	70%	79.0%	Strong

Legend:
YN = Yes/No Box   **DTTY** = Denbridge Text Telephone   **CTTY** = Comarco Text Telephone **CL** = Connect Light
HH = Hard of Hearing   **H** = Hearing   **D** = Deaf   **SI** = Speech Impaired

Call Connection and Completion Time

The results of the observer ratings for two categories, time required to initiate a call and time required to complete a call, are reflected on the following table:

Table 2: Call Connection and Completion Time

	CCL	DTTY	CTTY	Y/N
Avg time to initiate call	43 sec	49 sec	80 sec	46 sec
Avg time to complete call	67 sec	167 sec	129 sec	72 sec

Note:

- Average Time to Initiate Call: The CL box required the least amount of time to initiate a call because there is no communication device for the hearing or speech impaired. The CTTY box required the most time because the caller was required to answer a series of questions before the call box would call out to the operator.

- Average Time to Complete Call: The DTTY required the most time to complete because the keyboard was smaller and in a vertical position which made it difficult for the caller to utilize the keyboard (unlike the Comarco TTY whose keyboard is larger and in a horizontal position). The Comarco TTY allows for simultaneous use of the keyboard and handset, which allowed some verbal communication between the operator and those that could speak.   The CL took the least amount of time for completion as there is no method of communication between the hearing and/or speech impaired caller with the call box answering center.

Consultant Observations

During testing and while conducting other performance tests the consultant observed the following:

Comarco TTY:

- The TTY failed to deploy and sometimes retracted during a call.
- The TTY seemed to be preferred by participants because of the lower horizontal shelf positioning.
- The elderly participants seemed to have difficulty depressing the membrane type keys on the TTY.

Comarco Display Screen on both the TTY and Yes/No Call Box

- The display screen became unreadable in direct sunlight for some participants unless the screen was somehow shaded.
- The way in which the screen displayed word wrapping of text was confusing to most participants.

Denbridge TTY

- Because the TTY is vertically mounted on the face of the call box the keyboard was less comfortable for the participants to use.
- The Denbridge display screen was difficult to see at night when there was a bright light source behind the call box.
- Sometimes participants complained that the words scrolled too fast across the display screen.
- Even with these shortcomings each participant was successful in completing the call with the Denbridge TTY.

Call Connect Light

- The participants had difficulty seeing the call connect light during the day unless they were standing directly in front of the call box because the light is small and recessed.
- Most participants did not understand when the process of using the call connect light was complete or what the result was from the light flashing.
- False flash when call connects to the cellular system.

E.   PROJECTED UTILIZATION

The demographic information for California obtained by the consultant indicates the following population groups that can be considered as potential users of the access options:

- 7% of the California population is hard-of-hearing
- 1% of the California population is deaf
- 1% of the California population is speech impaired
- 91% of the California population is hearing

During the course of this study, information was gathered as to the frequency of call box assistance requested by persons with speech and/or hearing impairments. Should calls be placed in this manner, that information would only be gathered by the dispatch center that takes the call. Since the majority of the dispatch centers are operated by the CHP, and since the CHP database does not track those calls automatically, then those calls would have to be monitored manually, or recalled subjectively by the dispatcher. The dispatch centers answered by entities other than the CHP do require and have the ability to track and monitor this information. The following information has been gathered to date:

- The San Diego SAFE has installed call connected lights in their system. To date, their dispatch center has not recorded any types of calls which utilized tapping as a means of requesting help.
- Since the MTC SAFE installed about 250 Yes/No boxes in January 2000, only one call was made using the yes/no functions and not the handsets.
- The Santa Cruz SAFE has also installed call connected lights in their call boxes. Over the past year, their dispatchers have reported that they have had two calls where tapping was used to seek help.
- Based on information provided by the Barstow CHP dispatch center, dispatchers have not reported any incident of receiving a call from a hearing- or speech-impaired person tapping on the mouthpiece.

F.   COST

Cost information was obtained by the consultant from the access option vendors' published price lists. The individual SAFEs fall into a broad spectrum of financial conditions from agencies with large reserves to agencies that are facing funding shortfalls now, as well as in the near future.   The cost and benefit of each access option relative to installation, operation, and maintenance versus the relative financial resources of each agency is a critical issue for each SAFE. However, given the wide variations in financial resources among the SAFEs, the TAC has determined that each SAFE will develop its own cost/benefit analysis of access alternatives, utilizing the cost data provided in this study.

The table below summarizes the installation, operation and maintenance costs of the access options.

Table 3: Cost Summary

	Call Connect Light	Denbridge TTY	Comarco TTY	Yes/No
Installation cost [a]	NA	$750	$1,200	$700
Operations cost	Included	Included	Included	Included
Maintenance cost [b] (Preventive & corrective)	Included	$8 more per call box per month	$7 more per call box per month	$5 more per call box per month
Call Center Costs – TTY answering equipment	Unchanged	$2,000 computer/ printer	$3,100 TTY/PAP	$1,800 TTY/ 911-ITX

a. Source: Comarco Universal Price List, effective March 15, 2000.
b. It is important to note that these costs were based on a rate of $170 per box per year for preventive and corrective maintenance costs.

G. SUMMARY OF FINDINGS

The following table summarizes the major findings of this study. Table 4 organizes these findings by access option.

Table 4: Summary of Findings by Call Box Access Option

FINDING	CL	Denbridge TTY	Comarco TTY	Comarco Yes/No
1. Legal Compliance	Yes	Yes	Yes	Yes
2. Complies with call box specifications	Yes	Yes	Yes	Yes
3. Enabled successful non-voice communications with the operator	No	Yes	Yes	Yes
4. Allows for simultaneous voice, TTY, or data connection to call center operator	No	No	Yes	Yes
5. Requires additional procedures and training for call answering operators	No	Yes	Yes	Yes
6. Cost for call box modification	None	$ 750	$ 1,200	$ 700
7. Cost for call box answering equipment at call center operator positions (per position)	None	$ 2,000	$ 3,100	$ 1,800
8. Time required for the caller to initiate a call	43 seconds	49 seconds	80 seconds	46 seconds
9. Time required to complete a call	67 seconds	167 seconds	129 seconds	72 seconds
10. Overall rating by those tested for all features (Percentage of those tested in each group that preferred a particular option):				
• Hard of Hearing				78.8%
• Deaf			79.3%	
• Speech Impaired (didn't use the keyboard)		79%		
• Hearing *		81.8%		81.8%
11. Combined overall rating by all groups	62%	76%	69%	81%

* *The Y/N and Denbridge call boxes were both rated at 81.8%*

7. CONSULTANT RECOMMENDED IMPROVEMENTS

Based on the findings of this study the following additional suggestions could improve the overall usability and acceptability of the call box to the disabled community:

- **Call Connect Light:** Implement a surface mounted light that is visible from the side and fix the false flash problem. Provide clear instructions on use.

- **Comarco Yes/No Screen:** Explore a way to allow the caller to "back up" or de-select an option or specific response to a question so that the wrong information is not sent to the operator answer center. One solution might be to identify a low voltage version of the banking industries ATM screen. This feature could be integrated into the call box design. An ATM design would also be more universally known and accepted by the public at large.

- **Operator Answering Center:** Explore the use of PC based TTY software to be used at the operator position as an alternative to the expensive and complicated TTY, PAP, and Ameriphone III-PRS devices currently being used by the CHP. In addition, more prerecorded text messages can be programmed to handle more types of incidents on a PC based TTY than on the current TTY configuration.

8. CONCLUSIONS

Based upon the evaluations performed for this project the following conclusions have been determined:

- All of the access options comply with state and federal legal requirements.

- Although the consultant identified a number of functionality and minor specification compliance concerns, no compliance problems result in a significant performance failure for any of the access devices.

- No major equipment reliability problems were identified during this project, however, equipment failure rate and frequency of repair data was not provided by the access option vendors.

- The display screen, message wording and message transmission protocol for the Comarco TTY, Yes/NO and Denbridge TTY options resulted in reading difficulties or created confusion for a significant number of user testing participants.

- All of the access options are compatible with the cellular network and can be accommodated by either CHP or private calls centers. However additional equipment, operating procedures and staff training at the call center are necessary for all but the call connect light option.

- By combining all groups, the call boxes were ranked in the following order:

    1st: The YN call box received the highest rating, 81%
    2nd: The DTTY received the next highest overall rating, 76%
    3rd: The CTTY received an overall rating of 69%
    4th: The CL call box received an overall rating of 62%

- Maintenance and Operational Costs: The maintenance and operational costs for all of the access options are similar, however the Comarco TTY installation cost is significantly higher than the installation cost of the other options.

- All of the call boxes and their related components that were tested were in need of improvements to match the level of reliability and usability of the basic roadside call box currently in use throughout most SAFEs.

- It is the opinion of the consultant that most of these deficiencies can be addressed through modifications to the hardware and software components, improvements in call answering and processing procedures, and appropriate instructional aids be provided to the public as clearly written instructions within the call box and through public information efforts. Any future SAFE procurement projects for ADA access designed call boxes should take into account most of the operational issues and recommended improvements revealed by this study.